

**Fall Walleye Index Netting of
South Sector 5, Lake of the
Woods, Ontario: 1997 and 2002**

NWSI Technical Report TR-137

January 2006



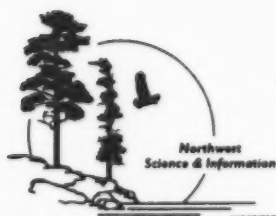
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by

T. Mosindy
and
J. Mucha



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Abstract

Results of a 2002 fall walleye index netting (FWIN) project in South Sector 5, Lake of the Woods, Ontario were compared with those from a previous FWIN survey of this sector in 1997. Improvements in the status of sauger and northern pike populations were observed, but walleye abundance, based on a geometric mean catch of 12.6 walleye per lift, remained largely unchanged from 1997. Although the number of mature fish, along with the contribution of older age and size classes, had increased slightly, several factors indicated that this population was still in recovery from past overexploitation. Walleye older than age seven were poorly represented in the recent survey. Total annual mortality rates, especially for males (47%), remained high and relative fecundity, estimated at 75.5 eggs per gram of total weight, was well above the average for northern Ontario walleye populations. A decline in walleye condition and growth since 1997 was attributed to increased competition for food and lower abundances of preferred prey species, especially yellow perch, cisco, and spottail shiners.

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Introduction

This report is based on the results of fisheries assessment work conducted by the Lake of the Woods Fisheries Assessment Unit (LWFAU) and Ministry of Natural Resources' Kenora District in South Sector 5 of Lake of the Woods, Ontario. Data were collected during fall walleye index netting (FWIN; Morgan 2002) in the fall of 2002 and compared with a previous FWIN in this sector in 1997. This work supplements a long-term fish community index netting (FCIN) program that has been regularly conducted in this sector by the LWFAU since 1982 (Mosindy 1983). Most recent FCIN sampling occurred in 1995–96 and 2001–02. FWIN data from this study were also compared with results from FWIN projects conducted on other parts of Lake of the Woods in recent years.

Study Area

Lake of the Woods is a 385,000 ha lake, extending 106 km north to south and 105 km east to west. It borders Ontario, Minnesota, and Manitoba with about 65 percent of its surface area within Ontario (Schupp and Macins 1977). The lake is made up of distinct basins which range from oligotrophic lake trout waters on the deeply cut Precambrian shield in the north and east to the shallow mesotrophic basin in the south. Here, the rugged landscape is replaced with the gentle relief of a glacial outwash plain and overlain by lacustrine sediments left by glacial Lake Agassiz. The Ontario portion of Lake of the Woods has been divided into seven sectors for fisheries assessment and management purposes, based on distinct physical and ecological characteristics.

South Sector 5 is the largest sector, covering 71,800 ha and extending from the mouth of the Rainy River northwards to Miles Bay (Figure 1). This sector is typically shallower and more turbid than the northern sectors. These waters tend to be homothermous and well oxygenated during most of the year with water clarity limited to secchi disc readings of 1 to 2 m. However, dense algal blooms composed mainly of the blue-green algae, *Aphanizomenon flosaquae*, can reduce secchi disc readings to less than 0.6 m in late summer. Sector 5 has an estimated potential fish yield of $4.25 \text{ kg} \cdot \text{ha} \cdot \text{yr}^{-1}$ and a morphoedaphic index (MEI) of 12.5 (Ryder 1965), based on a mean depth of 5.5 m and total dissolved solids (TDS) of $86 \text{ mg} \cdot \text{L}^{-1}$. The MEI in adjacent Big Traverse Bay, Minnesota is 18.6 (Schupp and Macins 1977).

Methods

Gill netting, which followed the FWIN protocol (Morgan 2002), was conducted on Sector 5 in 1997 and 2002. The FWIN net is a standard 61 m monofilament gill net composed of eight panels 7.6 m long by 1.8 m of increasing mesh size (25, 38, 51, 64, 76, 102, 127, 152 mm stretched measure), which are sewn together without spacing at a hanging ratio of 55 percent. Netting sites were randomly selected using a 100 x 100 m grid superimposed over a map of the waterbody (scale 1:50,000). The number of net sets (sample size) required were based on the amount of surface area to be sampled and the desired precision of the results, specifically a relative standard error of less than 20 percent for the average number of walleye caught per set. An equal number of net locations were randomly chosen between shallow (2 to 5 m depth) and deepwater (5 to 15 m), based on the known bathymetry of Sector 5. The mesh size to be set at the shallow end of the net alternated between large and small meshes. Netting was conducted at water temperatures from 10 to 15°C in the fall of the year when walleye distribution is least likely to be affected

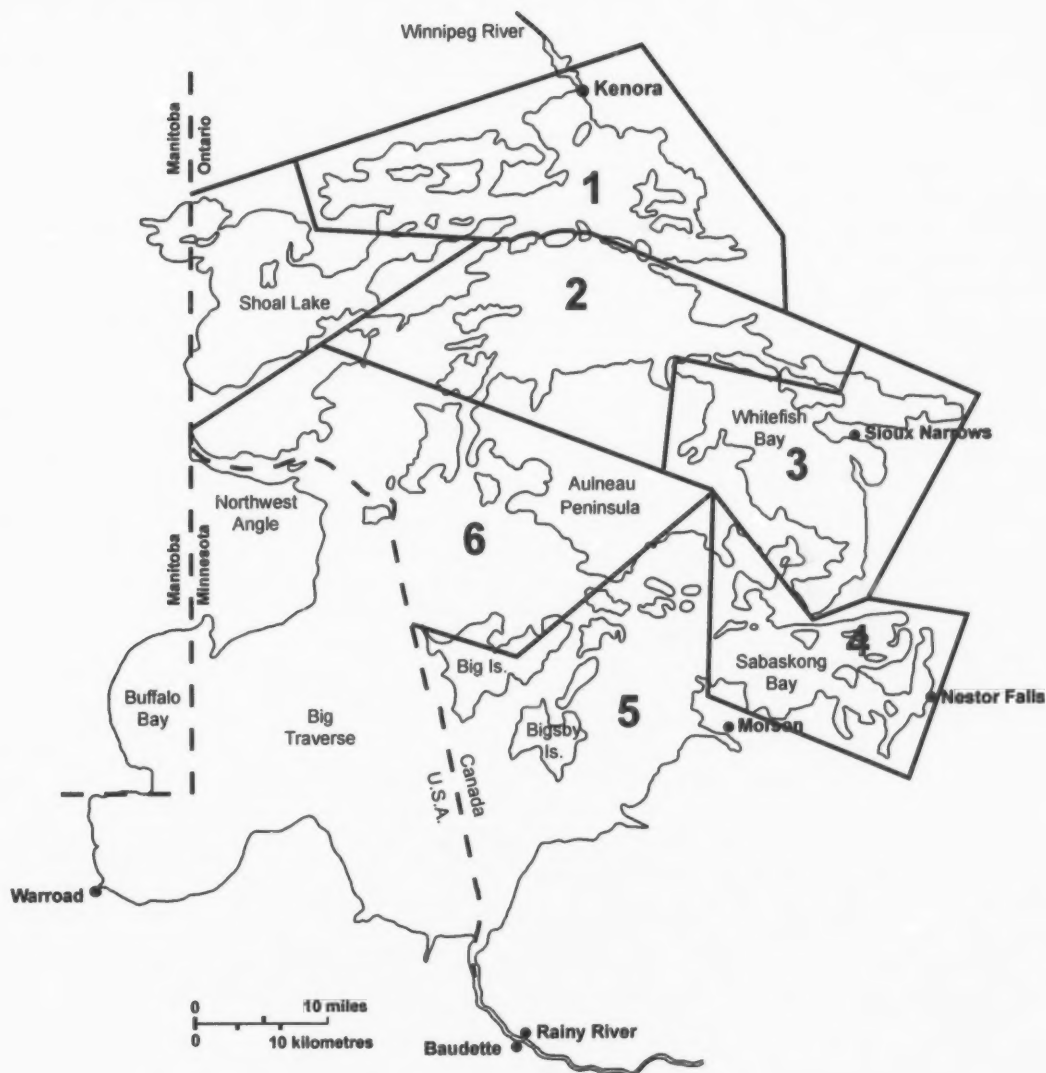


Figure 1. Location of Ontario sectors on Lake of the Woods.

by temperature. Nets were set in the morning and pulled approximately 24 hours later. Both surface and bottom water temperatures, along with the global positioning satellite (GPS) co-ordinates, were recorded at the terminal ends of each net at lift. All fish caught were identified, counted, and sampled by mesh size. Total and fork lengths, weight, sex, and state of maturity were recorded for all species in 2002. All primary species such as walleye (*Sander vitreus*), sauger (*Sander canadensis*), northern pike (*Esox lucius*), muskie (*E. masquinongy*), smallmouth bass (*Micropterus dolomieu*), largemouth bass (*M. salmoides*), black crappie (*Pomoxis nigromaculatus*), and lake sturgeon (*Acipenser fulvescens*) were sampled for ageing tissues that included scales and at least one other calcified structure (Mann 1993). All stomachs of primary species were examined for diet items which were identified and counted. Secondary species such as yellow perch (*Perca flavescens*), cisco (*Coregonus artedii*), and common white suckers (*Catostomus commersoni*) were sub-sampled at the rate of one out of every fourth fish for ageing tissues and diet.

Data from both 1997 and 2002 projects were entered into FISHNET 2.0 (Lester *et al.* 1989) and calculations for relative abundance, the mean and range in values for size and age, as well as condition or the weight-length relationship, were performed using this software. Relative abundance was not only expressed as the arithmetic mean number of fish caught per net, pooled across all strata, but as the geometric mean catch per net, based on the average of individual observations transformed to $\text{Log}_{10}(x+1)$. Weight-length relationships were developed from individual round weights and total lengths that were transformed into Log_{10} values and fitted to a geometric mean predictive regression model. These were then back-transformed to give a predictive equation for condition, expressed as:

$$(W = \alpha L^{\beta})$$

where W = round weight (g), L = total length (mm), α = the intercept and β = slope.

The Shannon Diversity Index (Krebs 1989), a common measure of biodiversity in ecological study, was used to evaluate the health and stability of the walleye population. This index was calculated from both the number of mature females and the number of age groups containing mature females in the population. The equation for this diversity index is:

$$H = -\sum_{i=1}^K p_i \ln p_i$$

where k is the number of different age groups with mature females, $p = n_i/N$ where n_i is the number of mature females within each age group, and N is the total number of mature females in all age groups.

Growth comparisons were based on mean total lengths-at-age data for both males and females. Pre-maturation growth (h) for walleye (Lester *et al.* 2000), which was defined as the growth rate up to 350 mm total length (TL) for the sexes combined, was calculated as:

$$h = 350 \text{ mm} / (T_{350} + 1)$$

where T_{350} was calculated from the mean total lengths of two consecutive age groups whose lengths fell around 350 mm. Asymptotic length was estimated using:

$$L_{inf} = L(1.0732 + 0.0223p - 0.0006p^2)$$

where L = geometric mean of p = the largest one percent of all fish of each sex in the sample.

Total length and age at 50 percent maturity were based upon logarithmically transformed (Log_{10}) age and length-at-maturity schedules (i.e., the percent mature at age or length) for males and females fitted to a logistic regression (Lysack 1980). Total annual mortality (A) was calculated using the Robson-Chapman estimator of survival (Robson and Chapman 1961, Ricker 1975) for age groups that were considered to be fully recruited to the gear.

Relative fecundity (RF) was calculated as:

$$RF = \text{Number of eggs} / W$$

where W is the wet weight of the fish in grams. The fall gonadosomatic index (GSI), was expressed as:

$$GSI = [\text{Gonad Weight} / (\text{Total Weight} - \text{Gonad Weight})] \times 100$$

where gonad weight and total fish weight were in grams.

Results and Discussion

FWIN netting began on September 17, 2002 and ran until the October 9th for a total of 68 sets. Relative standard errors based on mean number of walleye per net had dropped to below 20 percent after 25 sets and had stabilized at about 10 percent after 60 sets. A total of 60 sets were lifted between September 14 and October 1, 1997.

Fish Community Composition

Percids (i.e., yellow perch, walleye, and sauger) were the dominant group in FWIN nets during the 2002 assessment, comprising 75.4 percent of the catch by number (Figure 2) and 46 percent of the catch by weight (Figure 3). Yellow perch were the most numerous species (41.8%) while walleye were the most important in terms of total weight (23.6%), followed by cisco (23.5%). Other important species in terms of ranked catch weight were northern pike, sauger, white sucker, and yellow perch.

Figure 2. Species composition of the FWIN catch by number in 1997 and 2002, South Sector 5, Lake of the Woods, Ont.

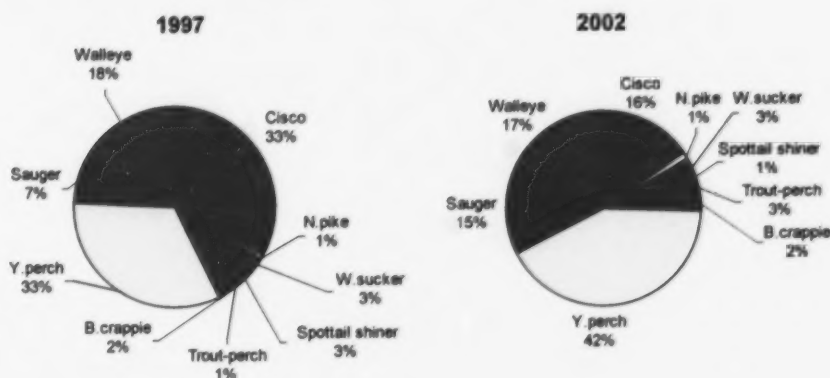
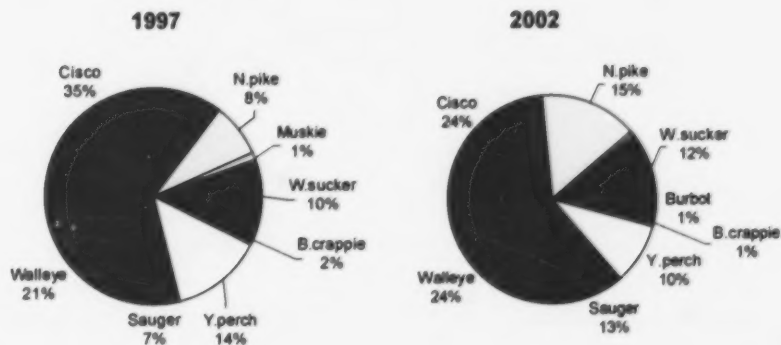


Figure 3. Species composition of the FWIN catch by weight during 1997 and 2002, Lake of the Woods, Ont.



It would appear that changes in the fish community of Sector 5, as illustrated by FWIN catches, have occurred between 1997 and 2002. Although both the mean number and weight of fish per lift were similar in 1997 (86.4 fish and 17.5 kg per lift) and 2002 (85.5 fish and 18.13 kg per lift), cisco numbers had decreased and sauger numbers had increased (Table 1). Cisco accounted for 15.6 percent of the FWIN catch by number in 2002, down from 33 percent in 1997 (Figure 2). Sauger numbers in FWIN nets more than doubled, from 6.7 percent of the total catch in 1997 to 15.4 percent in 2002.

Other species caught in FWIN nets included: lake whitefish (*Coregonus clupeaformis*), silver redhorse (*Moxostoma anisurum*), shorthead redhorse (*Moxostoma macrolepidotum*), quillback (*Carpiodes cyprinus*), spottail shiner

(*Notropis hudsonius*), trout-perch (*Percopsis omiscomaycus*), brown bullhead (*Ameiurus nebulosus*), burbot (*Lota lota*), rock bass (*Ambloplites rupestris*), black crappie, and pumpkinseed (*Lepomis gibbosus*). Changes in abundance of smaller prey species which are vulnerable to the smallest meshes in FWIN nets were observed between 1997 and 2002. Trout-perch, a primary prey of sauger, increased from 0.9 fish per lift to 2.7 fish per lift. Spottail shiners, an important food of walleye, would appear to have declined in abundance, from about 2.4 fish per lift in 1997 to 0.6 fish per lift in 2002. A similar decline in spottail shiner abundance was evident in a comparison of beach seine catches from this sector during 1995–96 and 2001–02.

Species	Mean number per lift				Mean kg per lift	
	1997	%RSE	2002	%RSE	1997	2002
L.sturgeon	0	0	0.01	100	0.00	0.03
L.whitefish	0.03	100	0	0	0.00	0.00
Cisco	28.5	21.3	13.32	11.4	6.22	4.26
N.pike	0.62	24.7	0.85	17.4	1.43	2.76
Muskie	0.03	70.1	0.01	100	0.19	0.08
W.sucker	2.18	17.4	2.31	14.1	1.84	2.19
S.redhorse	0.03	70.1	0.03	70.2	0.00	0.02
Quillback	0.05	74	0	0	0.00	0.00
Spottail shiner	2.43	26.7	0.62	57.1	0.03	0.01
B.bullhead	0.15	44.3	0.01	100	0.02	0.00
Burbot	0.08	43.2	0.09	39.3	0.04	0.14
Trout-perch	0.87	24	2.66	13.6	0.01	0.03
R.bass	0.23	85	0.09	39.3	0.02	0.01
Pumpkinseed	0	0	0.03	100	0.00	0.00
SMBass	0.02	100	0.12	48.9	0.01	0.08
B.crappie	1.92	29	1.66	31.8	0.27	0.18
Y.perch	28.42	16.9	35.71	38.8	2.41	1.79
Sauger	5.77	13.9	13.18	8.2	1.28	2.28
Walleye	15.17	14.3	14.76	9.9	3.76	4.27
All species	86.43		85.45		17.54	18.13
Total number of lifts	60		68			

Table 1. Catch per unit effort expressed as the mean number (with percent relative standard error) and weight (kg) per net lift by species in FWIN gill nets during 1997 and 2002, Sector 5, Lake of the Woods, Ont.

Walleye Abundance

Little or no change in walleye abundance was observed in FWIN catches from Sector 5 between 1997 and 2002. The mean catch or catch per unit effort (CUE) for walleye decreased slightly from 15.2 per net lift (relative standard error or RSE = 14.3%) in 1997 to 14.8 fish per net lift (RSE = 9.9%) in 2002. The geometric mean number of walleye per lift was 11.6 and 12.6 in 1997 and 2002. Arithmetic and geometric means of walleye per net lift differed, owing to inconsistent catches across net sets. The geometric mean for walleye in FWIN catches for northwestern Ontario lakes was 10.7 walleye per lift from 1993 to 2001 (Morgan *et al.* 2003). Geometric mean catches of 4.1 walleye per lift and 8.9 walleye per lift were observed from Shoal Lake (2001) and Sabaskong Bay (2000) during FWIN netting.

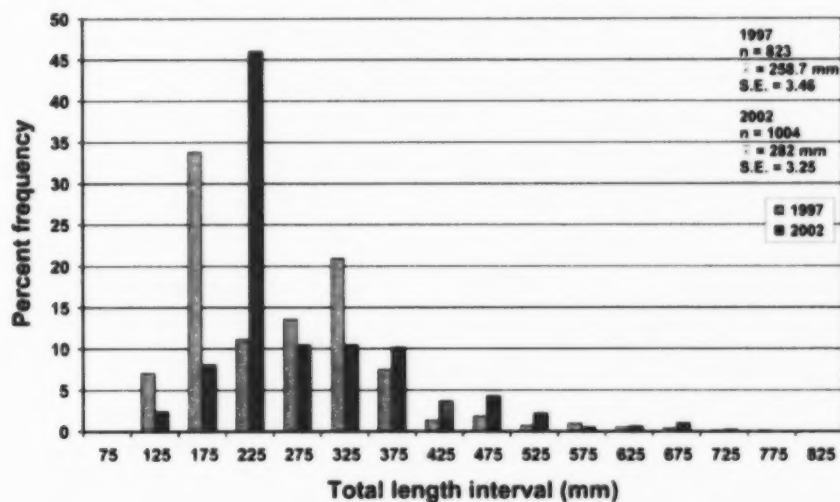
The representation of walleye in FWIN nets varied slightly from 17.6 percent to 17.3 percent of the total catch by number and from 21.5 percent to 23.6 percent of the total catch by weight between 1997 and 2002.

Sex, Size and Age Composition

Female walleyes predominated in FWIN net catches, representing 59.7 percent and 53.8 percent of the sample that could be sexed in 1997 and 2002. This corresponded to male : female ratios of 0.67 : 1 in 1997 and 0.86 : 1 in 2002. The fact that males began to mature earlier than females and could be more easily identified within the strong 2001 year-class would account for this observed increase in 2002. The Shannon Diversity Index value (H), based on the number of mature walleye by age group, was calculated at 0.80 in 1997 and 0.88 in 2002. This was higher than 0.75 from the Sabaskong Bay FWIN catch in 2000. Values (H) greater than 0.66 indicate that the walleye population is healthy and stable (D. Pereira, Minnesota DNR, St. Paul; pers. comm.). The spawning stock biomass (SSB), based on catch per unit effort (CUEs) of mature males and females in catch samples, increased slightly from 1.6 in 1997 to 2.1 mature fish per lift in 2002. Corresponding SSB values for males increased from 1.1 to 1.4 while relative abundance of mature females increased from 0.55 fish per lift in 1997 to 0.75 fish per lift in 2002.

Most walleye caught in Sector 5 during 1997 and 2002 FWIN netting were smaller than 250 mm TL (Figure 4). The proportion of walleye less than 250 mm total length (TL) remained fairly stable at 52 percent in 1997 and 56.5 percent in 2002. Walleye in FWIN nets ranged from 118 to 745 mm TL in 1997 and 114 to 760 mm TL in 2002. The mean total length of walleye from Sector 5 FWIN nets increased slightly from 258.7 mm in 1997 to 282 mm in 2002, which was below mean total length values from Shoal Lake in 2001 (394 mm; Gillies 2003), Sabaskong Bay 2000 (339 mm), and the Winnipeg River 1998 (328 mm). The percentage of "quality sized" fish (greater than 380 mm TL; Weithman 1984) increased from 11.8 percent in 1997 to almost 21 percent of the catch during the 2002 assessment. Relatively few "preferred sized" walleye (greater than 510 mm TL) were caught, representing about 2.4 percent and five percent of total catches in 1997 and 2002 (Figure 4).

Figure 4. Total length frequency comparison of walleye caught in fall walleye index gill nets during 1997 and 2002, South Sector 5, Lake of the Woods, Ont.



A shift to slightly larger walleye in the 2002 FWIN has been paralleled by a shift to slightly older fish. Walleye averaged 1.3 years and 2.2 years of age in 1997 and 2002. Walleye caught in FWIN nets were predominantly zero to three years old, comprising 94 percent and 85 percent of the catch in 1997 and 2002 (Figure 5). Strong year-classes dominated FWIN catches in both years.

A strong 1997 year-class represented over 41 percent of the sample in 1997, as young-of-the year, while the 2001 year-class comprised 62.5 percent of the FWIN catch in 2002 as one year olds. A total of 15 year-classes were caught in FWIN nets in 2002 while 14 year-classes were observed in 1997, with the oldest walleye being 18 years old. However, walleye greater than four years of age remained poorly represented and fish greater than or equal to 7 years of age comprised less than four percent of the total sample in both years.

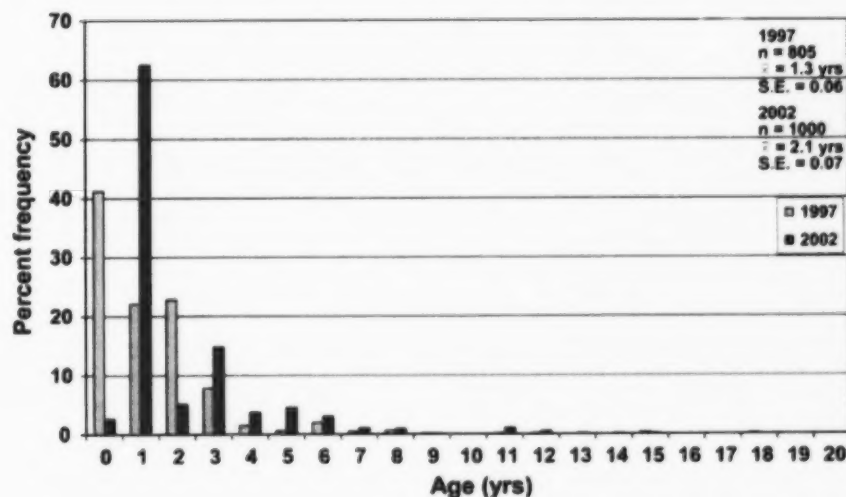


Figure 5. Age frequency comparison of walleye caught in fall walleye index gill nets during 1997 and 2002, South Sector 5, Lake of the Woods, Ont.

Weight-Length Relationship

The weight-length relationship was calculated as:

$$W = (11.31e-006) (L^{2.96}) \text{ for walleye (sexes combined) in 1997}$$

and

$$W = (2.12e-006) (L^{3.24}) \text{ for walleye (sexes combined) in 2002}$$

Similar relationships, calculated for both male and female walleye, were applied against standard total lengths (i.e., 350, 400, 450, 500, and 550 mm) to provide a comparison of walleye weights-at-total length between years and sectors on Lake of the Woods (Table 2).

Table 2. A comparison of predicted weight (g) at total length for male and female walleye caught in fall walleye index nets during 1997 and 2002 from various sectors of Lake of the Woods, Ont.

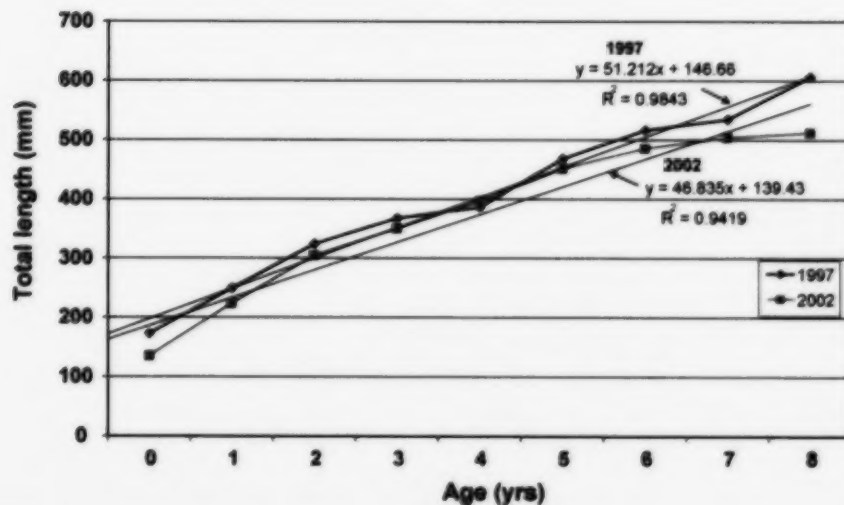
Sector	Sex	Weight-length relation		Calculated weight (g) at standard total lengths (mm)				
		β	$\alpha \times 10^{-4}$	350	400	450	500	550
South Sector 5 (1997)	Combined	2.96	11.31	383	569	807	1102	1461
South Sector 5 (2002)		3.24	2.12	367	566	829	1167	1589
South Sector 5 (1997)	Males	2.99	9.2	372	555	789	1080	1427
South Sector 5 (2002)		3.25	1.9	352	544	797	1123	1530
Sabaskong Bay (2000)		3.21	2.61	381	586	855	1199	1628
Shoal Lake (2001)		3.29	1.72	399	618	911	1288	1763
South Sector 5 (1997)	Females	3.01	8.5	386	578	824	1130	1506
South Sector 5 (2002)		3.23	2.15	346	533	780	1096	1491
Sabaskong Bay (2000)		3.27	1.84	375	580	854	1205	1645
Shoal Lake (2001)		3.24	2.47	420	647	948	1333	1816

It would appear that the condition of both male and female walleye in Sector 5, expressed as weight-at-total length, had declined between 1997 and 2002 (Table 2). While this decline in condition only affected males smaller than 450 mm TL, weights-at-length for all sizes of females were lower in 2002 than in 1997. Predicted weights-at-length for male and female walleye from Sector 5 in both years were substantially smaller than those of walleye sampled from Sabaskong Bay and Shoal Lake during similar FWIN projects (Table 2). Weights-at-length for Sector 5 walleye were also below average and fell within the lowest quartile when compared to weight-at-total length benchmarks for both male and female walleye from Northwest Region lakes (Morgan *et al.* 2003).

Growth

Walleye in the 1997 FWIN sample appeared to be larger at all ages, with the exception of age four, when compared with mean total lengths-at-age from the 2002 sample (Figure 6; Table 3). Linear regressions of age vs. mean total length from both years (Figure 6) indicated that growth had declined slightly between 1997 and 2002, based on differences in slope and intercept values. Mean total length-at-age values for both males and females (Table 3) fell between the 25 percent and 75 percent quartiles for Northwest Region walleye growth benchmarks (Morgan *et al.* 2003). Asymptotic lengths (L_{∞}) for female walleye had increased from 710 mm in 1997 to 744 mm in 2002, while L_{∞} values for males had decreased from 564 mm to 560 mm during the same period. Walleye appeared to exhibit slower growth during their early growth period (ages 0 to 3) in 2002 than in 1997. Prematuration growth (h) was calculated at 84.4 mm·yr⁻¹ in 1997 and 75.4 mm·yr⁻¹ in 2002. Although walleye growth has been found to be strongly related to the cumulative thermal history of any particular year-class (Lester *et al.* 2000), this factor could not account for observed differences in walleye growth between sampling years. All age groups sampled in 2002 were exposed to higher cumulative growing degree days (GDD) greater than 5°C than in 1997 (Figure 7), even though growth appears to have declined in recent years.

Figure 6. Mean total length-at-age comparison for walleye (sexes combined) caught in fall walleye index gill nets during 1997 and 2002, South Sector 5, Lake of the Woods, Ont.



Age	Males		Females		All	
	1997	2002	1997	2002	1997	2002
0	172.2 (62)	153.8 (5)	183.8 (95)	134 (1)	173 (332)	135.3 (26)
1	251.2 (63)	222.9 (295)	252.1 (72)	226.2 (295)	249.5 (178)	223.7 (625)
2	317.6 (64)	302.6 (26)	328.3 (102)	306.5 (25)	324 (184)	304.5 (51)
3	374.9 (21)	344 (56)	365.3 (35)	353.6 (92)	367.3 (62)	350 (148)
4	411.3 (6)	388.9 (17)	372.8 (4)	403.3 (20)	386 (12)	396.7 (37)
5	457.7 (3)	436.2 (18)	483 (2)	461 (27)	467.8 (5)	451 (45)
6	497.8 (4)	459.7 (10)	526.9 (10)	498.2 (20)	516.2 (16)	485.4 (30)
7	472 (2)	487.8 (4)	597 (2)	514.2 (6)	534.5 (4)	503.6 (10)
8	681 (1)	453.3 (3)	587.5 (4)	541.7 (6)	606.2 (5)	512.2 (9)

Table 3. A comparison of mean total lengths-at-age (mm) for male, female, and all walleye caught in fall walleye index gill nets during 1997 and 2002, South Sector 5, Lake of the Woods, Ont. Sample sizes appear in brackets.

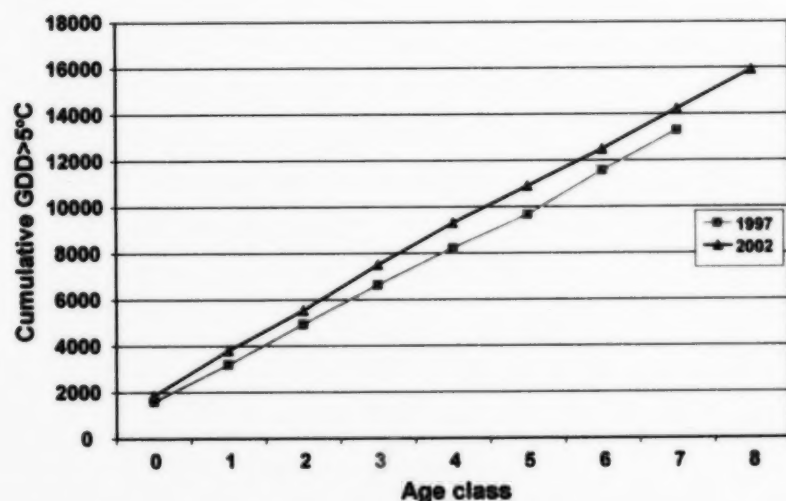


Figure 7. A comparison of cumulative growing degree days (GDD) greater than 5°C by age class for walleye caught in FWIN gill nets during 1997 and 2002, South Sector 5, Lake of the Woods, Ont.

Maturity

Differences in maturity schedules were evident between males and females and between sampling years. As is typical of this species, males achieved full sexual maturity before females. Maturing males and females were observed at the end of their second summer in both years. A total of 205 and 434 males, along with 304 and 511 females were examined for sexual maturity in 1997 and 2002. One hundred percent maturity was not reached until age five for males and age nine for females in 2002, as compared with age four for males and age nine for females in 1997. The mean age at maturity (Abrosov 1969) increased from 2.9 years to 3.5 years for males and 4.3 years to 6.6 years for

females in 1997 and 2002, respectively. A comparison of age at 50 percent maturity values also showed that walleye were maturing later in 2002 than in 1997. Age at 50 percent maturity for males and females was 2.2 and 3.9 in 1997 and 2.9 and 5.9 in 2002. Similarly, lengths at 50 percent maturity increased from 317.9 mm for males and 442.0 mm for females in 1997 to 338.3 mm for males and 495.6 mm for females in 2002. Maturity occurred at an older age than in Shoal Lake where ages at 50 percent maturity for male and female walleye were 2.0 and 2.9 years in 2001 (Gillies 2003). Ages and lengths at 50 percent maturity of 2.8 years and 349.4 mm for males, and 4.7 years and 461.3 mm for females were observed in FWIN samples from nearby Sabaskong Bay in 2000. Most female walleye from Sector 5 appeared to mature at an older age and larger size while most males achieved maturity at a younger age and smaller size than the Northwest Regional averages for mean age and length at maturity (Morgan *et al.* 2003).

Reproductive Characteristics

Mature ovaries were collected for fecundity analysis from 42 females, ranging from 461 to 745 mm total length and four to 15 years old, during the 2002 FWIN project (Appendix 1). Relative fecundity for South Sector 5 walleye in 2002 averaged 75.7 eggs per gram of total weight (S.E. = 16.4), within a range of 39 to 127 eggs per gram. This estimate was higher than the Northwest Regional average of 40.7 eggs per gram (Morgan *et al.* 2003).

The gonadosomatic index (GSI) for mature females was calculated as 2.64 percent from the 2002 fecundity sample. This was similar to the Northwest Regional average for female walleye of 2.62 percent (Morgan *et al.* 2003).

Mortality

Total annual mortality for walleye greater than or equal to five years old (Robson and Chapman 1961) increased between 1997 and 2002. Combined mortality for both sexes was calculated at 31 percent ($\sigma=0.079$) in 1997 and 35.6 percent ($\sigma=0.045$) in 2002. Female walleye had substantially lower mortality rates than males, especially in 2002. Total annual mortality rates increased from 32.3 percent ($\sigma=0.148$) to 47.4 percent ($\sigma=0.083$) for males and from 28.4 percent ($\sigma=0.098$) to 31.5 percent ($\sigma=0.054$) for females during 1997 to 2002. At almost 32 percent, female walleye mortality was only slightly higher than the regional mean of 28 percent, while males at 47 percent were much higher than the regional mean of 30 percent and fell within the upper 75 percent quartile (Morgan *et al.* 2003). Differences in total mortality rates between sexes and between assessment years were less pronounced when walleye greater than or equal to age three were included in the calculations. Total annual mortality for walleye greater than or equal to three years old remained at 39 percent overall during 1997 and 2002 while mortality increased from 43 percent to 45.4 percent for males and declined from 34.5 percent to 30.4 percent for females during the same period.

Sauger

Abundance

It would appear that sauger have increased in abundance in Sector 5, based on 1997 and 2002 FWIN catches (Figures 2 and 3). Sauger averaged 9.9 per net lift (geometric mean) in 2002, compared with 3.9 per net lift in 1997. The representation of sauger in FWIN nets increased from 6.7 percent in 1997 to 15.4 percent of the total catch by number in 2002 and from 7.3 percent in 1997

to 12.6 percent of the total catch by weight in 2002. Sauger averaged 2.28 kg per net lift in 2002, compared with 1.28 kg per net lift in 1997.

Size and Age Composition

A shift toward smaller sauger was observed in 2002 catches. The mean size of sauger caught in FWIN nets decreased from 283.7 mm TL in 1997 to 270.4 mm TL in 2002. Similarly, the percentage of sauger less than or equal to 280 mm increased from 32 percent in 1997 to 56 percent in 2002.

Sauger averaged 2.9 years of age in 1997 to 3.0 years of age in 2002. Twelve age groups were present in 2002 (age 0 to 10; 12) compared with nine groups (age 0 to 7; 10) in 1997 (Figure 8). The representation of sauger greater than or equal to age four also increased from 21.5 percent of the catch in 1997 to 31.6 percent in 2002. Strong year-classes appear to have been produced in recent years, especially in 1999.

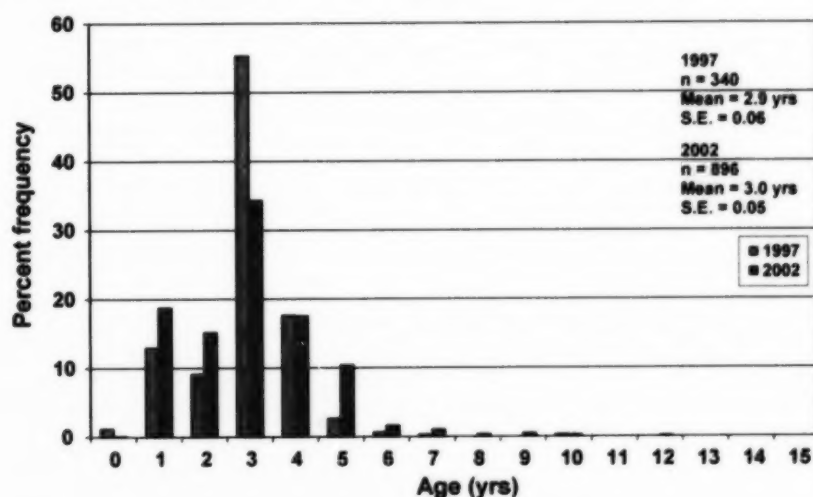


Figure 8. Age frequency comparison of sauger caught in fall walleye index gill nets during 1997 and 2002, South Sector 5, Lake of the Woods, Ont.

Growth

Growth rates of young sauger, expressed as mean total length-at-age (Table 4), declined during 1997 to 2002. However, both male and female sauger greater than or equal to age five were larger at age in 2002 than in 1997. After age two, females attained a greater size at age than males in both years.

Maturity

Differences in maturity schedules for sauger were evident between sexes and assessment years. Age at 50 percent maturity increased from 1.7 years for males and 2.7 years for females in 1997 to 1.8 years for males and 3.3 years for females in 2002. Full maturity was not reached until age five for males and age six for females in 2002. Length at 50 percent maturity for females increased from 275.4 mm TL in 1997 to 293.1 mm TL in 2002. Conversely, length at 50 percent maturity for males appeared to decrease from 245.5 mm TL to 222.7 mm TL during the same time period.

Mortality

Since sauger appeared to be fully recruited to FWIN gill nets at age three, total annual mortality (A) rates (Robson and Chapman 1961) were calculated for fish four years and older. Mortality was extremely high for both sexes but had declined between 1997 and 2002 assessments. Total annual mortalities for

Table 4. A comparison of mean total lengths-at-age (mm) for male, female, and all sauger caught in fall walleye index gillnets during 1997 and 2002, South Sector 5, Lake of the Woods, Ont. Sample sizes appear in brackets.

Age	Males		Females		All	
	1997	2002	1997	2002	1997	2002
0	140 (1)			132 (2)	140 (1)	132 (2)
1	202.2 (8)	185.4 (80)	202.6 (5)	193.7 (79)	203 (15)	188 (168)
2	255.7 (7)	245.2 (76)	254.4 (5)	242.5 (59)	255.9 (15)	243.4 (136)
3	280.9 (20)	272.2 (141)	300 (56)	284.4 (166)	295.8 (80)	278.8 (308)
4	300.6 (7)	296.7 (73)	317.3 (15)	318.2 (84)	311.9 (22)	308.2 (157)
5	298 (2)	319 (36)	334.7 (3)	341.5 (57)	320 (5)	332.8 (93)
6	318 (1)	327.6 (7)		355.4 (7)	318 (1)	341.5 (14)
7		343.3 (4)		392.2 (5)		370.4 (9)
8				391 (3)		391 (9)

the sexes combined were 76.6 percent in 1997 and 58.5 percent in 2002. Annual mortality rates dropped from 74 percent to 62.4 percent for males, and from 77 percent to 55.7 percent for females during this same period.

Northern Pike

Although FWIN nets were not as effective in capturing northern pike as other species (Morgan 2002), and resulting sample sizes were small, abundance and age/size characteristics of this species were compared in 1997 and 2002 catches.

The geometric mean number of pike per lift increased from 0.4 to 0.6 during 1997 to 2002. Relative abundance values were lower than those observed during FWIN netting in Sabaskong Bay (0.8 pike per lift) and Shoal Lake (1.0 pike per lift). Northern pike represented only 0.7 percent and 1.0 percent of the overall FWIN catch from Sector 5 by number in 1997 and 2002 (Figure 2). However, their contribution in biomass increased from about eight percent to 15 percent of the total catch by weight (Figure 3). Northern pike averaged 1.43 kg per lift in 1997 and 2.76 kg per lift in 2002.

Increases in both the mean size and age of northern pike in the 1997 and 2002 FWIN net catches were evident. The mean size of northern pike increased from 663.3 mm and 2,315 g in 1997 to 759.2 mm and 3,146.5 g in 2002. The mean age of northern pike caught in FWIN nets increased from 4.2 years in 1997 to 5.0 years in 2002. Only six age classes were present in the 1997 FWIN while 10 age classes were observed in 2002 (Figure 9). No northern pike older than age seven were caught in 1997, whereas individuals up to age 11 were observed and fish greater than age seven accounted for 17.2 percent of the catch in 2002.

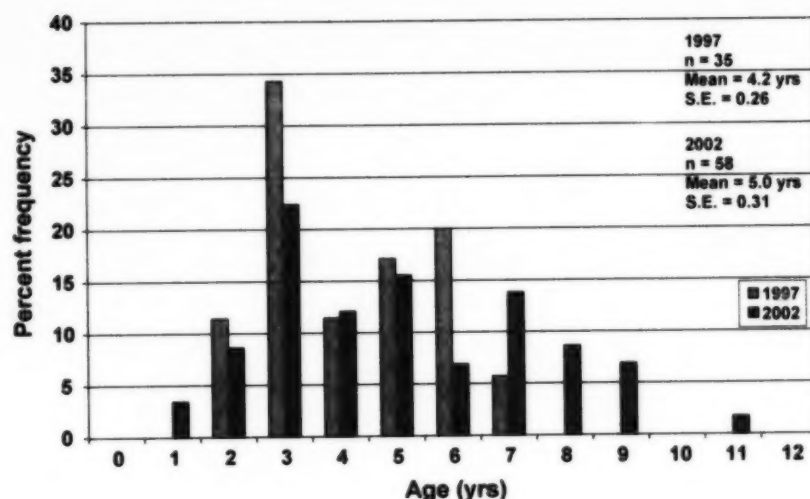


Figure 9. Age frequency comparison of northern pike caught in fall walleye index gill nets during 1997 and 2002, South Sector 5, Lake of the Woods, Ont.

Northern pike were first observed maturing at age two as males and age one as females in 2002, compared with age two for both males and females in 1997. All females were not mature until age four in 1997 and age 2 in 2002.

Total annual mortality (A) for the sexes combined, calculated for age three years and older, had declined from 40 percent in 1997 to 28.4 percent in 2002.

Yellow Perch

Abundance and Age/Size Characteristics

A comparison of 1997 and 2002 FWIN catches indicated a decrease in yellow perch abundance and a shift to increased numbers of younger and smaller individuals during this period. The geometric mean catch declined from 15.4 to 12.9 perch per net during 1997 and 2002. Although yellow perch comprised 33 percent and 42 percent of the total catch by number in 1997 and 2002, their representation in the overall catch biomass dropped from about 14 percent in 1997 to less than 10 percent in 2002. The average size of yellow perch declined from 187.6 mm and 84 g in 1997 to 167.7 mm and 74.2 g in 2002. The percentage of yellow perch heavier than 100 g also decreased during this time period from 32.7 percent of the catch in 1997 to 23.8 percent in 2002. The mean age of yellow perch in the catch similarly declined from 3.3 years in 1997 to 2.9 years in 2002. A greater number of age classes were present in net lifts during the 2002 assessment when nine age classes were caught, as compared with seven age classes in 1997 (Figure 10).

Growth

Growth rates of yellow perch in Sector 5, based on mean total lengths-at-age, were faster than those observed for both male and female yellow perch from nearby Sabaskong Bay during FWIN netting in 2000 (Figure 11). With the exception of age one, females were larger than males at most ages from both areas (Table 5).

Figure 10. Age frequency comparison of yellow perch caught in fall walleye index gill nets during 1997 and 2002, South Sector 5, Lake of the woods, Ont. The 1997 distribution was based on a limited sample size.

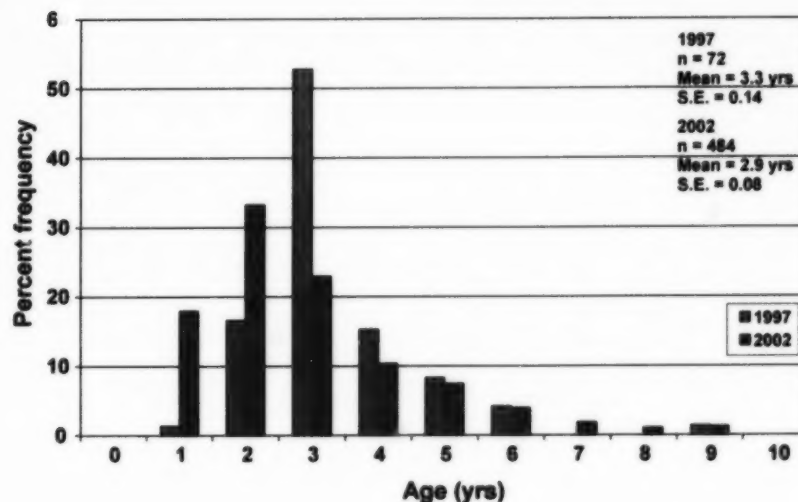
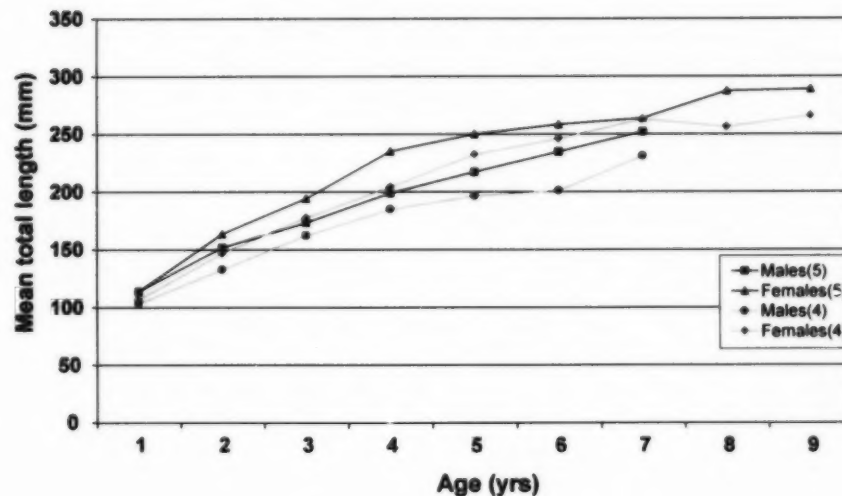


Figure 11. A comparison of mean total lengths-at-age for both male and female yellow perch caught in fall walleye index gill nets during 2000 and 2002 from Sabaskong Bay (4) and South Sector 5, Lake of the Woods, Ont.



Maturity

Most males were mature and/or maturing at age two and had reached full maturity by age three during fall walleye index netting in 2002. Most females were maturing by the end of their fifth summer and were fully mature at age five or 235 to 250 mm TL. Maturity rates for Sector 5 yellow perch were similar to those observed for both male and female perch from Sabaskong Bay during similar netting in 2000.

Mortality

A total annual mortality (A) rate of 46 percent for yellow perch greater than or equal to age three from Sector 5 was similar to that observed for perch sampled from Sabaskong Bay (47%) during the 2000 FWIN. Mortality has declined in Sector 5 when compared to an observed rate of over 60 percent during the 1997 FWIN, although the latter was based on a limited ageing sample.

Age	Males	Females	All
1	113.9 (42)	113.6 (43)	113.4 (87)
2	151.8 (71)	163.6 (89)	158 (161)
3	173.3 (36)	194.3 (75)	187.5 (111)
4	198.9 (15)	235 (35)	224.3 (50)
5	217.2 (5)	250 (31)	245.5 (36)
6	234.7 (3)	258.4 (16)	254.6 (19)
7	252 (1)	263.6 (8)	262.3 (9)
8		287.4 (5)	287.4 (5)
9		288.8 (6)	288.8 (6)

Table 5. A comparison of mean total lengths-at-age for both sexes of yellow perch caught in fall walleye index gill nets during 2002, South Sector 5, Lake of the Woods, Ont. Sample sizes appear in brackets.

Cisco

A substantial decline in cisco abundance in Sector 5 appears to have occurred, from an average of 28.5 fish per lift in 1997 to 13.3 fish per lift in 2002 FWIN catches. The contribution of cisco to the overall catch by weight also dropped from about 36 percent in 1997 to 24 percent in 2002 (Figure 3). Unlike yellow perch, which experienced both declines in abundance and size, the average size of cisco increased from 218.3 g in 1997 to 318.9 g in 2002. The mean total length of cisco in 2002 was 303 mm (range 186 to 407 mm). Cisco ranged in age from one to 11 years with no missing age classes and a mean age of 3.6 years. Since lengths and ageing tissues from ciscoes were not sampled in 1997, size and age comparisons between FWIN projects could not be made.

Growth rates of cisco from Sector 5 (Table 6) were similar to those observed from nearby Sabaskong Bay. However, both maturity and mortality rates differed. All males, age three and older, and all females, age four and older, were mature in the 2002 Sector 5 FWIN catch. Ciscoes were fully mature a year earlier in Sabaskong Bay: males at age two, and females at age three. Ciscoes, age three and older, appeared to have a higher total annual mortality (A) rate in Sector 5 (46.8%) than in Sabaskong Bay (36.4%).

Table 6. A comparison of mean total lengths-at-age for both sexes of cisco caught in fall walleye index gill nets during 2002, South Sector 5, Lake of the Woods, Ont. Sample sizes appear in brackets.

Age	Males	Females	All
1	214.3 (16)	214.4 (17)	214.3 (33)
2	269.9 (17)	277.4 (17)	273.7 (35)
3	301.6 (66)	302 (82)	301.8 (148)
4	340.4 (14)	329 (13)	334.9 (27)
5	339.2 (25)	336.7 (26)	337.6 (52)
6	350.6 (5)		345 (6)
7	366.8 (4)	346.5 (2)	360 (6)
8	350.5 (8)		348.4 (9)
9	359.9 (7)	382.5 (2)	364.9 (9)

Conclusions

Results from 1997 and 2002 FWIN projects on South Sector 5 support recent trends observed evident from long-term fish community index netting (T. Mosindy, MNR Kenora, pers. comm.). While the overall status of walleye populations in this sector remained largely unchanged, general improvements in the health and stability of sauger and northern pike populations were noted. Declines in the abundance of primary prey species, including cisco, yellow perch, and spottail shiners were also observed. Although some of these trends likely reflect natural fluctuations in abundance, others can be attributed to changes in exploitation during this period. The average annual commercial harvest of sauger was reduced from about 44,100 to 14,300 kg·yr⁻¹ and the reported annual walleye harvest was reduced from 56,800 kg·yr⁻¹ (1990–96) to 33,200 kg·yr⁻¹ during 1997–2002, primarily through retirement of non-First Nations commercial quotas and licences in this sector (OMNR 2004). Total harvest of yellow perch increased by 20 percent from 14,150 kg·yr⁻¹ during 1990–96 to 17,100 kg·yr⁻¹ during the 1997–2002 reporting period. Commercial harvest alone peaked at 35,800 kg in 1999, well above the potential yield estimate of 15,300 kg·yr⁻¹ (OMNR 2004).

Walleye abundance remained stable, as indicated by geometric mean catches of 11.6 and 12.6 fish/lift in 1997 and 2002. An average catch of 10.7 fish/lift was observed for walleye lakes in northwestern Ontario (Morgan *et al.* 2003). Both the age and size class structures of the population have broadened, the mean age and size of the catch has increased, and more age groups were present in 2002 than in 1997. The spawning stock biomass (SSB) has remained unchanged, with only a slight increase in numbers of mature male and female walleye in the samples. The diversity of mature female age groups (Shannon Diversity

Index = 0.88) would appear to be characteristic of healthy and stable populations. Both growth and maturity rates have changed since 1997 to within the normal range for walleye in nearby waters.

Several factors suggest that this population is still in recovery and that there is room for further improvement before annual harvests are allowed to approach the potential yield level. Walleye, age four and older, remained poorly represented in our 2002 FWIN catch. The vast majority of fish in the catch were smaller than 250 mm TL and the population continued to be dominated by single strong year-class events; in this case the 2001 year-class. Total annual mortality rates (A) for ages five and older had increased since 1997 and were high, especially for males (47%), when compared to populations in other parts of Lake of the Woods and northwestern Ontario. Relative fecundity, estimated at 75.7 eggs per gram of total weight in 2002, was considerably higher than similar estimates from other northern Ontario populations and within the expected range for more southern waters (Lester *et al.* 2000, Morgan *et al.* 2003). Increased fecundity has been acknowledged as a compensatory response to exploitation stress in walleye populations (Spangler *et al.* 1977, Baccante and Reid 1988).

Both condition and growth, especially pre-maturation growth, have decreased for male and female walleyes since 1997, in contrast to recent warming trends (i.e., GDD greater than or equal to 5°C) favourable for growth. Less available food, resulting from increased competition and lower abundances of preferred prey, could account for these declines. Increased food competition between species, resulting from observed changes in the fish community, seems more likely to have occurred than increased competition within the walleye population itself, since walleye abundance has remained relatively stable over this study period. Sauger whose abundance in FWIN nets more than doubled between 1997 and 2002 are known to compete directly with walleye for yellow perch and benthic invertebrates (e.g., mayfly nymphs), especially during the spring. Trout-perch are a primary food of sauger in the Minnesota waters of Lake of the Woods throughout the summer but are a minor component of the walleye diet in the same areas (Swenson and Smith 1976). Diet overlap is probably most important amongst young-of-the-year and juveniles of these species. An increase in the abundance of larger and older northern pike in 2002 FWIN catches could also contribute to increased predation on yellow perch, cisco, and spottail shiners.

Literature cited

- Abrosoy, U.N. 1969. Determination of commercial turnover in natural bodies of water. Problems of Ichthyology. Trans. (from Russian). Am. Fish. Soc. 9: 482 – 489.
- Baccante, D.A. and D.M. Reid. 1988. Fecundity changes in two exploited walleye populations. North American Journal Fisheries Management 8: 199 – 209.
- Gillies, M. 2003. Shoal Lake fall walleye index netting (FWIN), 2001. Anishinabek/Ontario Fisheries Resource Centre Technical Report. 21 pp.
- Krebs, C.J. 1989. Ecological Methodology. Harper & Row, New York.
- Lester, N.P., R.S. Kushneriuk, S. Orsatti, and D.G. Oliver. 1989. FISHNET user manual. Ontario Ministry of Natural Resources, Toronto, Ontario.
- Lester, N.P., B.J. Shuter, R.S. Kushneriuk, and T.R. Marshall. 2000. Life history variation in Ontario walleye populations: Implications for safe rates of fishing. Percid Community Synthesis. Population and Yield Characteristics Working Group. Ontario Ministry of Natural Resources. 34 pp.
- Lysack, W. 1980. 1979 Lake Winnipeg fish stock assessment program. Man. Dept. Natur. Resour. Manuscript. Rep. No. 80 – 30. 118 pp.
- Mann, S.E. 1993. Collection techniques for fish ageing structures. Ont. Min. Natur. Resour. Northwest Science and Technology. NWST Technical Report TR-73. 20 pp.
- Morgan, G.E. 2002. Manual of instructions – fall walleye index netting (FWIN). Percid Community Synthesis, Diagnostics and Sampling Standards Working Group. Ont. Min. Natur. Resour. 34 pp.
- Morgan, G.E., M.D. Malette, R.S. Kushneriuk, and S.E. Mann. 2003. Regional summaries of walleye life history characteristics based on Ontario's fall walleye index netting (FWIN) program: 1993 to 2001. Percid Community Synthesis, Diagnostics and Sampling Standards Working Group. Ont. Min. Natur. Resour. 192 pp.
- Mosindy, T. 1983. An assessment of the South Sector fishery, Lake of the Woods, 1982. Ont. Min. Natur. Resour. Kenora, Ont. Lake of the Woods – Rainy Lake Fish. Assess. Unit Rep. 1983 – 02. 114 pp.
- OMNR. 2004. Ontario – Minnesota Boundary Waters Fisheries Atlas. Ont. Min. Natur. Resour. Northwest Sci. & Info. Thunder Bay, Ont. 100 pp. + append.
- Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Board Can. 191. Ottawa. 382 pp.
- Robson, D.S. and D.G. Chapman. 1961. Catch curves and mortality rates. Trans. Am. Fish. Soc. 90: 181–189.
- Ryder, R.A. 1965. A method for estimating the potential fish production of north-temperate lakes. Trans. Am. Fish. Soc. 94: 214–218.
- Schupp, D.H. and V. Macins. 1977. Trends in percid yields from Lake of the Woods, 1888 – 1973. J. Fish. Res. Board Can. 34: 1784 – 1791.
- Spangler, G.R., N.R. Payne, J.E. Thorpe, J.M. Byrne, H.A. Regier, and W.J.

Christie. 1977. Responses of percids to exploitation. J. Fish. Res. Board Can. 34: 1983 – 1988.

Swenson, W.A., and L.L. Smith Jr. 1976. Influence of food competition, predation, and cannibalism on walleye (*Stizostedion vitreum vitreum*) and sauger (*S. canadense*) populations in Lake of the Woods, Minnesota. J. Fish. Res. Board. Can. 33: 1946 – 1954.

Appendix 1. Relative fecundity (number of eggs per gram of total fish weight) of female walleye sampled from fall walleye index gill nets during 2002, South Sector 5, Lake of the Woods, Ont.

Walleye Fecundity South Sector 5 FWIN 2002						
Sample	TLEN (mm)	Age	FISHWT (g)	GONWT (g)	Estimated FECUN	Eggs/g (FISHWT)
3-96-21	654	11	3050	68.10	247203	81
4-13-1	545	6	1650	36.00	123624	75
6-79-1	558	6	1652	32.72	150916	91
8-108-16	521	6	1400	31.00	89032	64
8-108-17	510	5	1276	22.53	120460	94
8-108-18	600	8	1904	37.77	177670	93
12-58-2	530	8	1524	28.94	119262	78
13-4-2	528	6	1522	45.94	139612	92
15-7-1	632	11	3050	82.09	236255	77
15-7-2	662	12	3050	88.52	196514	64
15-7-3	504	6	1208	26.27	94336	78
17-97-13	582	9	1750	28.20	146527	84
18-33-1	493	7	1164	22.41	116935	100
19-6-1	745	15	4150	82.69	297326	72
23-03-43	658	14	2950	87.52	213199	72
23-03-42	682	12	3450	86.31	316240	92
23-03-40	461	5	956	15.42	77994	82
23-03-41	482	5	1012	8.14	67448	67
25-17-4	670	11	3200	86.25	223848	70
26-87-12	663	13	2960	104.23	248380	84
27-92-1	600	11	2150	44.43	125337	58
28-95-8	508	6	1082	33.97	82060	76
33-104-1	697	11	3874	67.65	152754	39
40-86-14	486	5	970	18.64	123043	127
41-76-1	512	5	1306	25.95	138634	106
42-44-24	495	5	1066	22.16	83078	78
47-31-4	554	7	1576	51.82	139679	89
49-52-15	496	7	1112	27.09	77694	70
49-52-13	485	6	1036	20.60	75419	73
50-73-13	598	11	2308	67.64	144880	63
50-73-12	616	8	2382	62.65	157678	66
51-37-4	474	5	1060	24.98	74765	71
52-61-7	498	5	1178	32.21	66804	57
54-88-25	465	5	1060	28.84	78320	74
58-107-3	536	6	1534	55.03	115123	75
58-107-5	457	4	918	24.58	73396	80
58-107-4	505	6	1300	41.53	81523	63
58-107-7	468	5	1016	39.33	80430	79
59-05-35	507	6	1204	16.65	75425	63
63-22-19	702	12	3568	138.94	240042	67
65-60-12	506	8	1538	59.70	85908	56
65-60-10	650	11	2602	55.81	104365	40
Average			1874.238	48.15		75.71

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